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TREE GRADES AND ECONOMIC MATURITY FOR SOME APPALACHIAN HARDWOODS

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by

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TREE GRADES AND ECONOMIC MATURITY FOR SOME APPALACHIAN HARDWOODS

by
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INTRODUCTION

Choosing the right species and sizes of trees to cut or leave, improving appraisal accuracy, determining the tree's highest market value, and picking the best financial rotation are some of the more urgent reasons calling for workable and reliable tree grades and values. A better knowledge of quality in terms of grade yield or dollar values, and a better understanding of a tree's earning capacity would be of great help in choosing between borderline trees. This report is a revision and enlargement of an earlier station paper (3) proposing a tree grading system designed to separate Appalachian hardwood trees into appropriate value classes.

PAST WORK

The first widely recognized tree grading systems used in this country were primarily for determining risk classes in ponderosa pine. A combined value, vigor, and risk system of tree grading was first proposed and used by the U. S. Forest Service (7) in the Lake States.

The success of this system and the one originated in 1948 by the author (published in 1951 as Station Paper 9) demonstrated the usefulness and value of hardwood tree grading. These earlier efforts were followed by other workers in the field using a modification of the author's system (Cummings and Zarger, 5), or a system of grading each log in the tree (Guttenberg and Putnam, 8). Each of the latter publications was based on approved Forest Products Laboratory log grades which were not available when the author did most of his original field work.

TREE GRADES

The tree grades proposed are A, B, and C, and are based on the quality of the butt log of the tree. All log grades mentioned herein are based on the factory log grades 1, 2, and 3 as described in the Forest Products Laboratory report D 1737 (12). Tree grades have been given

a different designation from log grades in order to avoid confusion when discussing vigor classes. The proposed system of tree grading utilizes the recognized tendency for the upper logs in a tree to be of lower quality than those next below them. For example, in trees containing two or more logs, a grade 1 butt log is usually topped by a grade 2 upper log, and a grade 2 butt by a grade 3 upper. Trees containing more than one log were synthesized as described in the author's earlier publication (3). While this method of tree grading may be less accurate than grading each log in the tree, it is acceptably accurate and much simpler to use. The chore of grading and field tallying is reduced to a workable basis.

Since the tree grade depends on the quality of the butt log, the appraiser must examine this log closely. A table of condensed butt log specifications based on the Forest Products Laboratory specifications mentioned above and adapted from the Tennessee Valley Authority report (5) to include the latest TVA revisions, is shown in table 1.

Table 1.--Hardwood tree grades 1/

Tree grade	FPL butt-log grade	D.b.h. class: Usual	D.b.h. class: Minimum	Clearcuttings on grading face 2/: Maximum	Clearcuttings on grading face 2/: Minimum length: Single	Clearcuttings on grading face 2/: Minimum length: Total	Maximum defect: Sweep & crook	Maximum defect: Total cull 3/
		-- Inches --		No.	--- Feet --		-- Percent --	
A	1	18+	4/ 16	2	7	13	15	40
			18	2	5	13	15	40
			24	2	3	13	15	40
B	2	16+	12	2	3	11	30	50
			14	3	3	11	30	50
C	3	12+	10	8	2	8	50	50

1/ Based on quality of the first 16.3-foot length above the stump or jump butt, if any.

2/ This is the right-hand face of the two faces seen as the tree is approached.

3/ Total cull including crook and sweep. See Lockard, et al. (11) for type of defect and cull estimates.

4/ Ash and basswood only will admit 14-inch trees.

Size of tree is the primary factor to consider in tree grading. A tree must ordinarily be at least 16 inches d.b.h. before it can be considered for either of the upper two grades. If the tree meets this minimum size requirement, then the number of clear faces or length of clear cuttings on the grading face is the next guiding factor.

A choice of methods awaits the user in actually determining the grade of standing trees. He can examine all four faces of the butt log and select the next-to-poorest face for grading, as recommended by the Forest Products Laboratory in the grading of logs. This system is appropriate for tree grading whenever a careful inspection seems justified, as in high-value timber or in determining the value of a small group of trees. It is the system used in arriving at the values and maturity sizes given later in this paper (tables 4 and 5).

A short-cut system based on grading the single face that is to the right of the grader as he approaches the tree has been worked out by foresters of the Tennessee Valley Authority (5). Their system is most appropriate for grading relatively uniform second-growth timber, and for grading large numbers of trees. The authors of the short-cut system state that it "gave 76 percent accuracy with 10 percent of the remaining values (trees) over-graded and 14 percent under-graded" in comparison with grading of the next-to-poorest face (5).

As pointed out by Cummings and Zarger (5), the application of the Forest Products Laboratory log grades to tree grading tends to overgrade the trees because of log-end defects which are invisible until the trees are cut into logs. There is, however, a compensating factor in the use of the 16-foot requirement for a grading length. Many logs can be up-graded after the tree is felled by cutting them in shorter than 16-foot lengths.

Two of the log grade exceptions contained in the Forest Products Laboratory grades (12) are not included in this tree grading method. These are: permitting logs with 60 percent cull to drop one grade, because this would allow unmerchantable logs (in most species) to be graded; and including 10-inch d.i.b. logs in grade 2 if surface quality is grade 1, since it applies to only two species.

CONVERTING LOG YIELDS TO TREE VALUES

The next step concerns the determination of tree yields and values. They are based on and computed from log values in terms of Quality Index numbers. Quality Index as developed by Herrick (9) and modified by Ellertson and Lane (6) is the lumber value of the tree expressed as a percentage of the value of a given grade of lumber (No. 1 common in this study) per thousand board-feet. The Quality Index for a given tree multiplied by the current price of No. 1 common lumber of that species equals the dollar value per thousand board-feet of the lumber in that tree.

Preliminary studies by the author in 1951 indicated that butt logs and uppers in the same log grade and species should probably be separated because there was a considerable difference in grade yield, and hence

dollar values. Statistical comparisons of the Quality Index values for butts and upper logs using graded Tennessee Valley Authority and Forest Products Laboratory logs confirmed the earlier opinions. As a result of these tests, and using combined data from some 6,000 Tennessee Valley Authority and Forest Products Laboratory logs, separate yield curves by position in the tree were prepared for all log grades. For some species and grades there was not enough difference to justify keeping them separate so they were combined (for example, grade 2 butts and uppers in both ash and yellow birch).

By use of appropriate outside-bark form classes (77 for the oaks and 80 for others) and taper tables, small-end log diameters were computed for trees of 1-, 2-, 3-, and 4-log lengths and a range of diameters. Quality Index values previously computed in the log-grade study were inserted, assuming an orderly decline of one grade for each successive log going up the tree. Average Quality Index values for each tree grade, length, and diameter were then determined. These values were plotted and smooth curves were drawn from which tabular values for each 2-inch class were obtained. These curved Quality Index values are shown for northern red oak in table 2, and for 11 other species in the appendix, table 6. Cherry and buckeye are the only important species for which data were not available for Quality Index curves.

Table 2.--Quality Index values, northern red oak, by tree grade

D.b.h. (Inches)	1-log trees			2-log trees			3-log trees		
	A	B	C	A	B	C	A	B	C
	Quality Index Number								
12	--	--	55	--	--	54	--	--	53
16	97	80	60	89	69	59	81	66	58
20	102	84	65	94	74	64	85	70	63
24	106	89	71	98	78	69	89	74	68
28	111	93	76	102	82	74	94	79	73
32	115	97	81	106	86	79	98	83	78

These Quality Index tables provide the base for value computations which will be discussed later under the heading of tree values.

TREE VIGOR CLASSES

Practically all who have observed trees growing in the woods and many who work with wood products realize that there is a great range of growth rates within the same species. Various schemes of estimating growth rates based on size and shape of crown, root placement, bark character, and other factors have been studied. Three vigor classes are easily distinguishable and will permit sufficient separation of growth rates for practical purposes.

The bark is probably the most reliable single external indicator of tree vigor for the oaks. The crown is the most important feature in determining vigor of the other species and should not be ignored even for the oaks. Tree vigor-class descriptions for the red and white oak groups and yellow-poplar have been ably summarized by Burkle and Guttenberg (2). Examples of species and vigor classes are shown in figures 1 and 2.

The Tennessee Valley Authority foresters (5) recognized three classes of vigor: good, fair, and poor. Furthermore, they separated trees into these classes based on the number of rings in the last inch of radial growth so that trees with 7 or fewer rings were classed as good, 8-17 as fair, and 17 or over as poor. Table 3 describes the good and the poor Tennessee Valley Authority tree vigor classes. Excellent pictures illustrating all three vigor classes and details of bark character are shown in the publication (5) mentioned above.

For the other species not included in table 3 we have reduced Holcomb and Bickford's (10) crown class ratings for yellow-poplar and associated species to three classes and have included some item specifications as follows:

Vigor class I -- Trees in this class have large crowns and are dominant or codominant. The crowns are dense with no evidence of disease or mechanical injury. The main trunk is sound and upright and only minor defects are allowed.

Vigor class II -- Crowns in this vigor class are fair sized and in a codominant position with only the tip exposed to direct sunlight. The crown may be open with some dead or broken limbs. This class includes overtopped trees of tolerant species that have dense crowns of good color.

Vigor class III -- These trees have small, overtopped crowns. Included are all living trees that fail to meet the requirements of the two higher vigor classes. Rot or decay may be considerable. Heavy-lean and root-sprung trees are included here.

Table 3.--Characteristics of tree vigor classes [1] for major hardwood species

Features	Good vigor, up to 7 rings per radial inch	Poor vigor, 17 or more rings per radial inch
Crown	Large, healthy, full and dense with strong limbs; balanced; not competing closely with other crowns.	Small with weak or dead primary limbs; broken-topped or large limb stubs; major unbalance; close competition with other crowns.
Main trunk	Sound, upright, no more than slight sweep; minor defects only.	Rot or decay may be considerable, heavy lean or bend, weak crotches; major visible defects.
Roots	Strongly anchored.	Root-sprung.
Bark by species:		
White oak [2]	Dark-colored with elongated fissures; surface on ridges is generally flat with ridges only infrequently broken.	Light-colored with short and less distinct fissures; ridges interrupted by many cross breaks. Thin bark on 1 or more faces.
Chestnut oak	New bark, flesh-colored, in fissures (this alone does not define good vigor); fissures shallow and elongated.	New bark may still be evident; fissures generally deep; cross breaks in ridges common.
Black, scarlet, northern red and southern red oaks	New bark evident in shallow fissures.	No new bark evident, but if present, confined to a few fissures; bark thicker, fissures deeper.
Hickory	New bark conspicuous in shallow fissures.	No new bark evident; fissures deeper.
Yellow-poplar	New bark light in color with prominent V-shaped, shallow fissures	No new bark evident; fissures generally deep; bark thick with elongated ridges.

1/ From Table 3 (5). The "fair" vigor class is important, but is described as intermediate between "good" and "poor," with 8 to 16 rings per radial inch.

2/ Criteria for white oak adapted from Burkle and Guttenberg (2).

Figure 1.--Distant and close view of a grade A, vigor class I hard maple 21 inches d.b.h.

Figure 2.--Distant and close view of a grade A, vigor class II white ash tree 23 inches d.b.h.

GROWTH RATES

Although past growth can be measured by use of an increment borer, it is a slow procedure. Consequently, Holcomb and Bickford's work (10) in defining vigor classes and showing the corresponding growth rates is of great help. Growth data from table 8 of their publication were plotted for each species by vigor classes, and smooth curves were drawn through the points. Growth rates based on their studies, on Tennessee Valley Authority data (5), and on data collected near Asheville, N. C. are shown in figure 3. Growth rates in vigor classes I, II, and III from this chart were used in computing tree maturity sizes.

The author's 10-year radial growth data were taken on more than 500 trees representing 11 out of the 13 species common to the Southern Appalachian area. Only beech and yellow birch were omitted, since they are rather scarce locally. Basswood, sugar maple, and the hickories were the only three species studied which grew at the same rate as in the West Virginia study (10). Both ash and red maple were growing from 30 to 40 percent faster in western North Carolina than in West Virginia. The big differences were in the reversed positions of yellow-poplar and northern red oak. Locally we found northern red oak trees of class I vigor averaging 3.6 inches d.b.h. in growth during the last 10 years, compared with 2.3 inches for West Virginia. Yellow-poplar is growing as well here as there, since it was found to average 2.5 inches for sawlog-size trees. Growth rates for the oaks in general closely paralleled those observed by Cummings and Zarger (5). Our maturity figures, which were based on the West Virginia growth data, should be conservative.

Growth was not clearly related to diameter in the oaks, maples, and basswood. For such species as ash, hickory, and yellow-poplar, growth seems generally to decline with increased d.b.h. -- at least in vigor class I (see figure 4). In yellow-poplar especially, growth drops rapidly with increasing size, as observed by Holcomb and Bickford (10). For example, we found a drop of over 1 inch in d.b.h. growth per decade between 14- and 34-inch trees in both vigor classes I and II.

TREE VALUES

Having computed and curved tree Quality Indices as previously outlined, the next step was to determine lumber values per M b.f. for trees of each grade and a range of diameters and log lengths. This was done by multiplying the Quality Index number for a given size and grade by the current lumber value per M b.f. of No. 1 common lumber for that species. These computed values were plotted and smooth curves drawn for all species as shown in figure 5 for northern red oak. This figure illustrates good stratification of values between grades, and serves to point out the effect of merchantable length on tree values per M b.f. These lumber

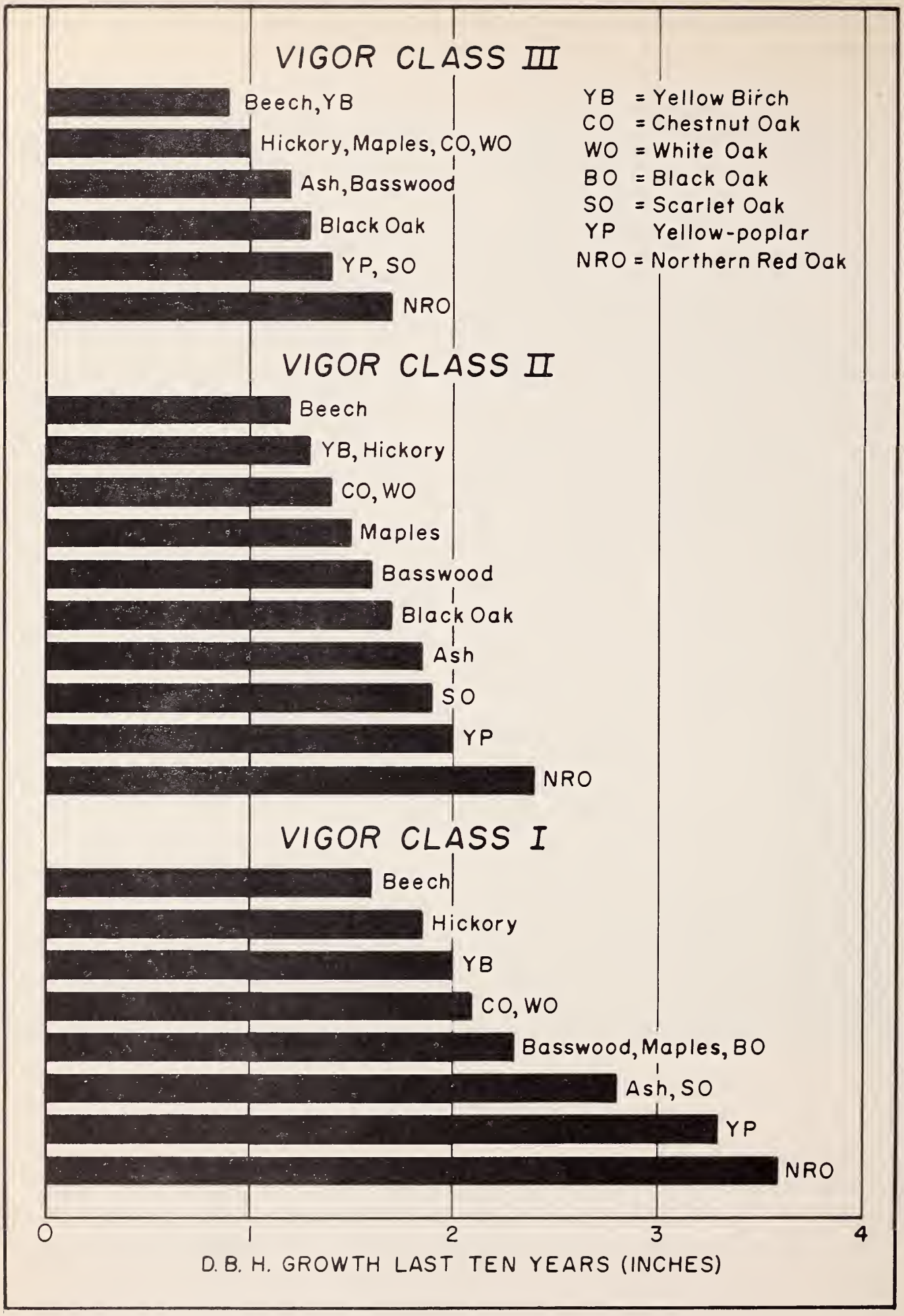

Figure 3.--Average diameter-growth rates of Appalachian hardwoods by species and vigor class, based on data from studies by Holcomb and Bickford (10), Cummings and Zarger (5), and the author.

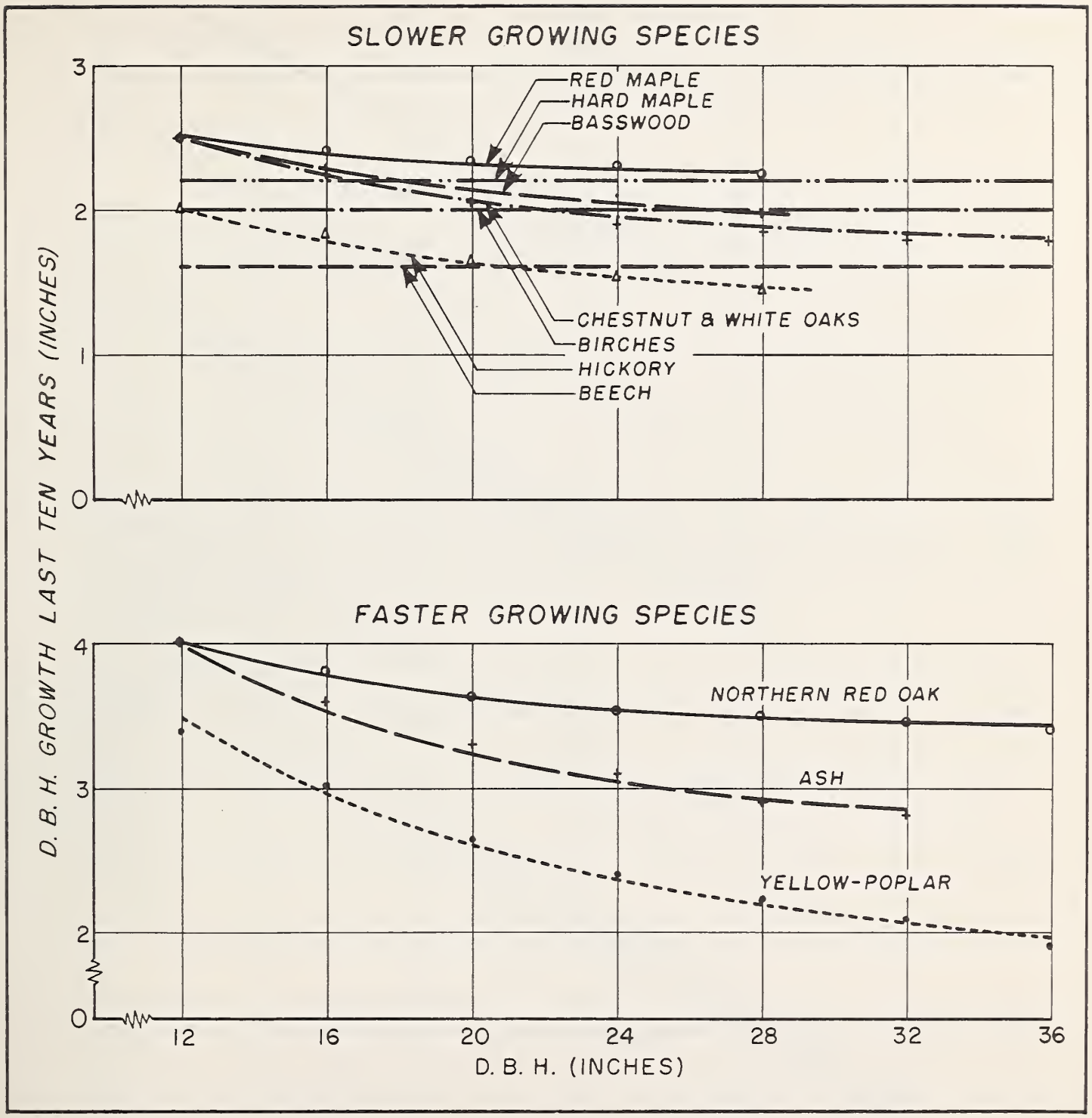

Figure 4.--Average growth rate of trees in vigor class I, according to species and tree diameter. Beech and birch data are from West Virginia (10). The author's Southern Appalachian data were used for the other species.

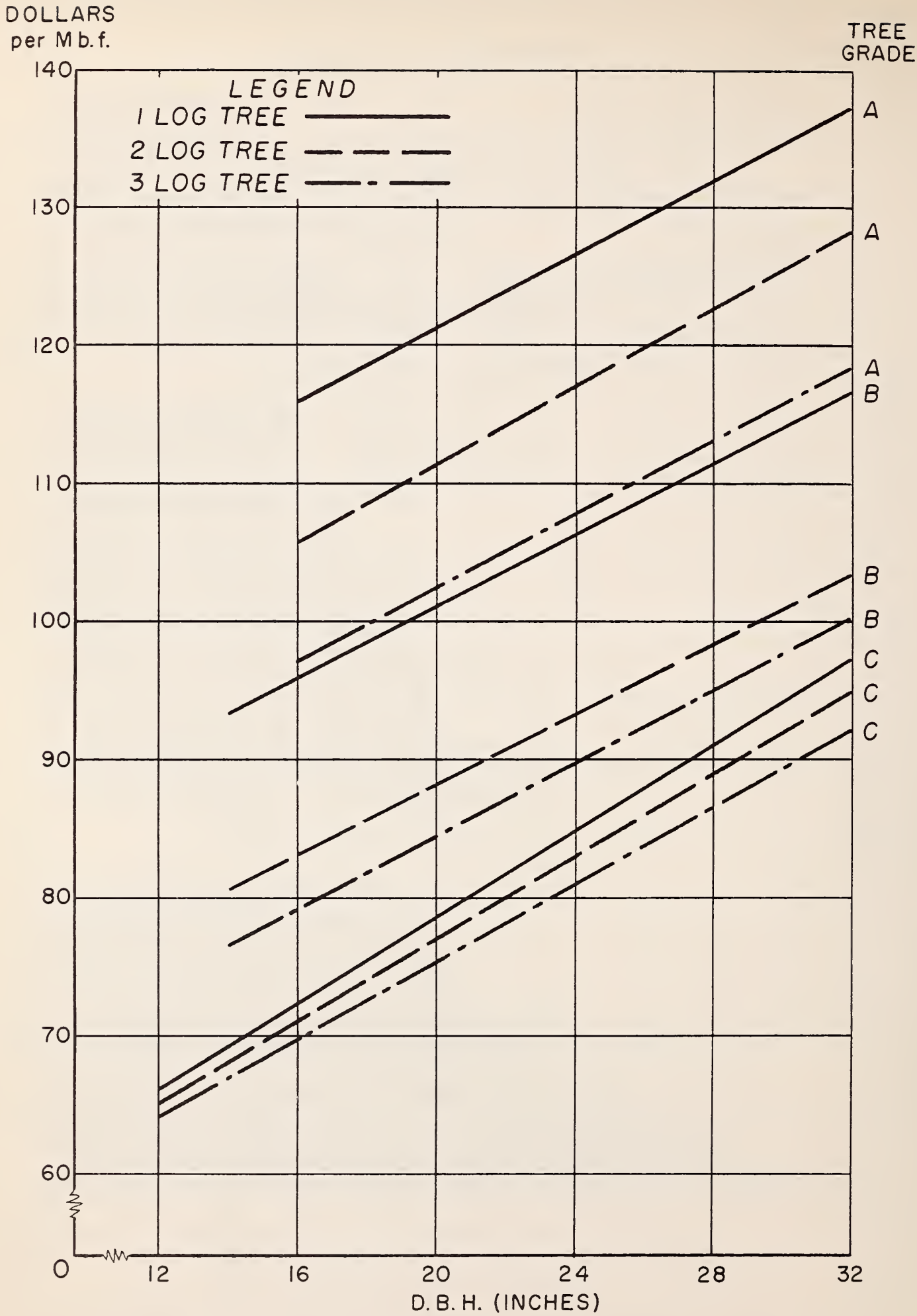

Figure 5.--Lumber value of northern red oak by tree grade and diameter. The values are based on band-mill prices from the Hardwood Market Report of October 1953 applied to grade-yield data from the Appalachian territory.

values are useful in appraisals and for other purposes, but before we can compute economic maturity sizes we need to know the relative stumpage values of various tree sizes and grades.

In order to compute stumpage values, we must know or assume some conversion costs (logging and milling) plus a margin for profit and risk. These costs are deducted from the lumber values computed above. A table of logging and milling costs per M b.f. by d.b.h. class was prepared and is shown as table 7 in the appendix. Some cost factors had to be assumed, such as length of skid and length of haul and road construction costs. Timber cutting, skidding, loading, and hauling costs were taken from Southeastern Forest Experiment Station Paper 30 (4). Milling costs for band mills as given in appraisal instructions of Region 8 of the United States Forest Service were adjusted to tree size based on Tennessee Valley Authority time studies. Band-mill costs were needed since band-mill lumber values were used above in computing tree values. Circular-mill costs and selling prices would be equally suitable if they could be obtained. The profit and risk margin was computed as a percentage of the lumber value, as in the usual Forest Service appraisal.

With stumpage values still on an M b.f. basis, it was necessary to convert them to a tree basis by use of the same tree volume tables used earlier in computing weighted Quality Indices. These computed stumpage values were then plotted and curves were drawn so that intermediate values could be read from the curves. These values are shown in table 4 for northern red oak and in appendix table 8 for other species. The values shown are purely illustrative, since both selling prices and production costs change with time and location.

Table 4.--Tree stumpage values[1/] of northern red oak by tree grade
(In dollars)

D.b.h. (Inches)	1-log trees			2-log trees			3-log trees		
	A	B	C	A	B	C	A	B	C
12	--	--	.15	--	--	.30	--	--	.35
14	--	--	.40	--	--	.70	--	--	.80
16	4.40	2.60	.90	6.40	2.80	1.40	6.60	3.00	1.70
18	6.60	4.10	1.80	9.50	4.60	2.80	10.00	5.30	3.50
20	9.50	6.20	3.10	13.50	7.20	4.80	15.00	8.80	6.00
22	12.50	9.00	4.90	19.00	11.00	7.80	21.50	13.00	9.60
24	16.00	12.00	7.00	25.00	15.00	11.50	29.00	19.00	14.00
26	20.00	15.00	9.30	31.50	20.00	15.50	37.00	25.00	19.00
28	24.00	18.00	11.80	38.00	25.00	19.50	45.00	31.50	24.00
30	27.00	21.00	14.00	44.00	30.00	24.00	53.00	38.00	29.00

1/ Tree values shown were read from curves on semi-log paper.

Stumpage values read from the above curves were then listed for each 2-inch diameter class for each log length and for each tree grade of the species for use in computing economic maturity. The increase in value from one d.b.h. class to the next was determined, and this increase divided by the initial value gives the percentage increase. This increase when related to the time required to grow the 2 inches determines the economic maturity.

ECONOMIC MATURITY

Economic maturity in this paper is considered as the tree size beyond which the increase in value (per 2-inch d.b.h. class) is less than 3-percent compounded annually. The 3-percent figure was chosen as a suitable rate for public properties. Adjustment factors for computing economic maturity sizes at other interest rates are given at the end of this section.

Appropriate growth rates by species and vigor class (fig.3) produced the maturity sizes shown in table 5 for the various species and grades. For vigor class I most trees are economically mature at 26 inches d.b.h. plus or minus 1 inch according to the grade of the tree. For vigor class II, they become mature at 22 inches d.b.h., plus or minus 1 inch, and for vigor class III maturity comes at a still smaller size--about 19 inches d.b.h. Separate groupings of fast- and slow-growing species by vigor class had little effect on maturity size except in Class I, where an inch faster growth than was used in table 5 resulted in an average of 2 inches larger d.b.h. at maturity. Details of maturity sizes by tree grade and log lengths are shown in appendix table 9.

Table 5.--Economic maturity 1/ by species, vigor class, 2/ and log length
(In inches)

Species	Vigor class I		Vigor class II		Vigor class III		
	10-year growth 3/	Maturity d.b.h. 4/	10-year growth 3/	Maturity d.b.h. 4/	10-year growth 3/	Maturity d.b.h. 4/ 1 log	Maturity d.b.h. 4/ 2 or more
Ash	3.20	29	2.00	24	1.20	19	18
Basswood	2.30	24	1.60	21	1.20	16	16
Beech	1.60	24	1.10	19	.80	18	18
Yellow birch	2.00	26	1.30	21	.80	19	19
Hickory	1.85	27	1.30	24	1.00	21	23
H. maple	2.30	24	1.50	20	1.00	16	15
R. maple	2.30	26	1.50	22	1.00	18	18
Y. poplar	2.80	26	1.85	23	1.40	18	18
Black oak	2.30	26	1.70	23	1.30	20	21
Scarlet oak 5/	2.80	23	1.85	21	1.40	18	20
N. R. oak	3.60	30	2.30	25	1.70	22	22
Chestnut oak	2.10	25	1.40	21	1.00	21	21
White oak	2.10	25	1.40	20	1.00	18	19
Average	2.4	26	1.60	22	1.1	19	19
Range	1.6 - 3.6	23 - 30	1.1 - 2.3	19 - 25	.8 - 1.7	16 - 22	15 - 23

1/ Assuming equal growing time between each 2" d.b.h. and 3 percent minimum return.
2/ Vigor classes as described by Holcomb and Bickford (10).
3/ Growth rates are taken from figure 1.
4/ Average for tree grades A, B, C.
5/ Based on values shown in Tennessee Valley Authority report (5). Sizes shown under class I are average for B, C grades; grade A matures at 16 inches. In class II, grade B matures at 17 inches.

A word of caution is needed regarding the economic maturity of hickory and yellow-poplar. Practically all the No. 1 hickory logs were from the Central States area; apparently grade A trees are uncommon in the Appalachians. Hickory is shown to mature at a relatively larger size, but this is due primarily to the negative tree values up to about 20 inches d.b.h. Yellow-poplar on the other hand is "normal" in that positive values are indicated above 14 inches, but the growth rate (2.8 inches) used for this vigor class may be too high (1) for trees over 24 inches d.b.h. (see fig. 4). Consequently, it is believed that trees of this species when managed for lumber production will not justify holding beyond 27 inches d.b.h., even in vigor class I, when a 3-percent return is required. When held for veneer, perhaps 30 inches is the maximum. However, we do not have at present a sound basis for estimating this upper limit. On the other hand, our studies indicate northern red oak, for example, will maintain the rapid growth rate indicated through the maturity sizes shown.

If a species is growing faster than shown in table 5, maturity sizes are increased. For example, in northern red oak a diameter increase of 2 inches in 5 years instead of 8 increased the maturity size an average of 5 inches in vigor class I.

Though the maturity sizes shown in table 5 are based on average grade yields usually from a wide area and average growth rates, there are good reasons for localized variations in economic maturity sizes. The case for holding northern red oak to 30 inches based on local growth rates has already been mentioned. Ash and red maple can also be held to larger sizes here than in West Virginia for the same reason. Sugar maple for example, can also be held locally to a larger size (probably 28 inches) in spite of a similar average growth rate because of higher local lumber yields and values. On poor sites where the growth rates and yields would be below average, a smaller economic maturity size is indicated. The actual size can be computed once the local growth rate is known.

Volume growth alone will seldom justify holding the tree much beyond its peak of current annual increment. The return from volume increment alone in trees that have already attained financial maturity is estimated to be only 1 to 3 percent according to Cummings and Zarger (5). As clear lumber becomes scarcer and value of larger clear trees increases, it may pay to hold the better trees to larger sizes than those shown here.

Low-value trees should not be kept solely because they are earning a high rate of interest on a small capital investment. In mixed stands particularly, we should favor the high-value species and individuals in order to obtain maximum returns per acre.

Decreasing the 3-percent minimum acceptable rate of earning by 1 percent raises the economic maturity size by an average of 3 inches d.b.h. for most species and vigor classes. Increasing the rate 1 percent

(to 4 percent) lowered the maturity size by the same amount, except in vigor class II and III, where for many species only grade C trees could meet the 4-percent requirement. Grade A trees would have to be cut as soon as they reach the minimum size.

It will pay to hold most species listed in table 5 beyond their normal economic maximum d.b.h., if they are in vigor class I or II, and if there is a chance of their increasing a grade (quality class) or increasing one log in merchantable length while growing the next 2 inches in diameter. Thus, a grade B or C tree mature at 20 inches could be held over if a grade or a log increase is likely by the time of the next cut. Usually the rate of return during this period will exceed 4 percent compounded, depending on the species, grade, and vigor class.

SUMMARY

This paper traces the development of hardwood tree grading from its origin in the Lake States to its present stage of refinement in the Appalachians. The author's contribution of synthesizing grade yields, and quality index values for whole trees from those of graded butt and upper logs is also summarized. His analysis of yields of some 6,000 Forest Products Laboratory logs and some 4,000 Tennessee Valley Authority logs has resulted in improved yield estimates for several of the dozen commercially important species of the Southern Appalachian region.

The use of vigor classes as indicators of growth rates, while not new, has been considerably refined in recent years. In most cases, correct cataloguing of vigor class eliminates the need for boring a tree to determine its growth rate. The author's own local growth studies were used in combination with others, or separately, in order to predict the size at which economic maturity is attained by the various commercial species and classes of trees found in the Southern Appalachians.

Tree grading alone should greatly improve the accuracy of timber sale appraisals over the present system of estimating average tree quality.

Percentage earnings of all species decline as the tree gets larger--for any single use such as lumber. Earnings also decline from high to low vigor class, as might be expected.

In choosing between two sound trees of the same approximate size, equally spaced, leave the faster growing one. Furthermore, a tall tree should be left in preference to a short one. Hold for the next cut any tree of high-value species in vigor class I or II if there is a chance of its increasing a grade or a log length by that time.

Holding a tree beyond the economic maturity size shown in this paper may be well justified if it can qualify for a special use more valuable than lumber, such as veneer or stave bolts.

The basic tables given in the appendix can be used for computing new tree and stumpage values for any given location or change in lumber values.

LITERATURE CITED

(1) Bickford, C. Allen
1953. An aid in choosing the right tree to leave. Northeastern Forest Expt. Sta. Paper 65, 8 pp.

(2) Burkle, J. L., and Guttenberg, Sam
1952. Marking guides for oaks and yellow poplar in the southern uplands. Southern Forest Expt. Sta. Occasional Paper 125, 27 pp.

(3) Campbell, R. A.
1951. Tree grades, yields and values for some Appalachian hardwoods. Southeastern Forest Expt. Sta. Paper 9, 26 pp.

(4) _____
1953. Logging methods and costs in the Southern Appalachians. Southeastern Forest Expt. Sta. Paper 30, 29 pp.

(5) Cummings, W. H., and Zarger, T. C.
1953. Guide for improved forest management for sawtimber from the major hardwoods in the Tennessee Valley, TVA Div. Forestry Relations, 56 pp.

(6) Ellertson, Birger W., and Lane, Paul H.
1953. Lumber price ratios for computing quality index of Tennessee Valley hardwoods. TVA Div. Forest Relations, Tech. Note 15, 13 pp.

(7) Goetzen, C. B., Parton W. W., Stott, C. B., and Stone, J. H.
1943. Suggested hardwood tree class standards for farm foresters. U. S. Forest Serv. Region 9, 33 pp.

(8) Guttenberg, Sam, and Putnam, John A.
1951. Financial maturity of bottomland red oaks and sweet gum. Southern Forest Expt. Sta. Occasional Paper 117, 24 pp.

(9) Herrick, Allyn M.
1946. Grade yield and overrun from Indiana hardwood sawlogs. Purdue U. Agr. Expt. Sta. Bul. 516, 60 pp.

(10) Holcomb, Carl J., and Bickford, C. Allen
1952. Growth of yellow poplar and associated species in West Virginia as a guide to selective cutting. Northeastern Forest Expt. Sta. Paper 52, 28 pp.

(11) Lockard, C. R., Putnam, J. A., and Carpenter, R. D.
1950. Log defects in southern hardwoods. U. S. Dept. Agr. Handbook 4, 37 pp.

(12) U. S. Forest Products Laboratory
1949. (Wellin, A. C., Vaughn, C. L., et al.) Hardwood log grades for standard lumber, proposals and results. Report No. D1737, 60 pp.

APPENDIX

The following tables are included for the purpose of permitting new computations of tree values based on different lumber prices and logging costs. They may also be used in computing different economic maturity sizes based on local growth rates and stumpage values.

Table 6.--Quality index by tree grade and size

D.b.h. (Inches)	1-log trees			2-log trees			3-log trees		
	A	B	C	A	B	C	A	B	C
WHITE ASH									
12	--	--	70	--	--	68	--	--	67
14	96	88	74	91	79	71	85	76	70
16	101	92	77	95	83	75	89	80	74
18	105	96	80	99	87	78	93	84	77
20	110	100	84	103	91	82	97	87	81
22	114	105	87	108	95	85	101	91	84
24	118	109	91	112	99	89	105	95	87
26	123	113	95	116	103	92	109	99	91
28	127	117	98	120	107	96	113	103	94
30	132	122	102	125	111	99	117	107	98
BASSWOOD									
12	--	--	73	--	--	68	--	--	66
14	109	94	75	99	82	70	90	77	68
16	112	96	78	101	84	72	92	78	70
18	115	98	80	103	86	75	94	80	73
20	118	99	82	106	87	77	97	82	75
22	122	101	84	108	89	79	99	84	77
24	125	103	87	111	91	82	101	86	79
26	129	104	89	113	93	84	104	88	82
28	132	106	91	115	95	86	106	90	84
30	135	108	93	117	97	88	109	92	86
BEECH									
12	--	--	50	--	--	49	--	--	48
14	83	65	52	75	58	51	67	56	50
16	85	68	55	77	61	54	70	59	52
18	88	71	58	79	64	56	72	61	55
20	90	74	60	82	67	59	75	64	58
22	92	77	63	84	69	61	77	66	60
24	94	80	65	87	72	63	80	69	62
26	96	83	68	89	75	66	82	72	65
28	98	86	70	91	78	68	85	74	67
30	101	89	73	94	81	71	87	77	70
YELLOW BIRCH									
12	--	--	39	--	--	38	--	--	37
14	75	60	42	66	52	40	59	48	39
16	81	65	44	72	55	43	64	51	42
18	88	70	47	78	59	45	69	55	44
20	95	74	50	84	63	48	74	58	47
22	102	79	52	90	66	50	79	61	49
24	108	84	55	96	70	53	84	64	52
26	115	89	57	102	74	55	89	68	54
28	122	93	60	108	77	58	94	71	57
30	129	98	62	113	81	60	99	74	59
HARD MAPLE									
12	--	--	64	--	--	63	--	--	62
14	92	78	66	85	72	65	79	69	64
16	94	80	68	87	74	67	81	71	66
18	96	81	70	89	76	69	83	73	68
20	98	83	72	91	78	71	85	75	70
22	100	85	75	93	79	74	87	77	73
24	102	86	77	95	81	76	89	79	75
26	104	88	79	96	83	78	91	81	77
28	106	89	81	98	84	80	93	83	79
30	108	91	83	100	86	82	95	85	81
SOFT MAPLE									
12	--	--	60	--	--	57	--	--	56
14	88	75	63	74	67	60	70	64	58
16	91	79	66	78	70	63	73	67	61
18	94	83	69	81	73	66	77	70	64
20	98	87	72	85	76	68	80	73	66
22	101	91	76	89	79	71	83	75	69
24	105	95	79	93	82	74	86	78	71
26	108	98	82	96	85	77	90	81	74
28	112	102	85	100	89	80	93	83	76
30	115	106	89	104	92	83	96	86	79

D.b.h. (Inches)	1-log trees			2-log trees			3-log trees			4-log trees		
	A	B	C	A	B	C	A	B	C	A	B	C
YELLOW POPLAR												
12	--	--	71	--	--	67	--	--	65	--	--	64
14	85	82	73	80	75	69	76	71	67	73	70	65
16	88	84	75	83	76	71	78	73	69	75	71	67
18	91	86	77	85	77	73	80	75	71	77	73	69
20	95	87	79	88	79	75	82	76	73	79	74	71
22	98	88	81	90	81	77	85	78	74	81	76	73
24	102	90	83	93	82	78	87	79	76	84	77	75
26	105	92	85	95	84	80	89	81	78	86	79	76
28	108	94	87	98	86	82	92	82	80	88	80	78
30	112	95	89	100	87	84	94	84	82	90	82	80
HICKORY												
12	--	--	43	--	--	41	--	--	40	--	--	--
14	93	71	47	78	59	45	67	55	44	--	--	--
16	97	75	51	81	63	49	71	58	48	--	--	--
18	101	79	55	84	67	53	75	62	52	--	--	--
20	105	83	59	88	71	57	78	65	56	--	--	--
22	108	87	63	92	75	61	82	70	60	--	--	--
24	112	91	67	95	79	65	86	74	63	--	--	--
26	116	95	72	98	83	69	89	77	67	--	--	--
28	120	99	76	102	87	73	93	81	71	--	--	--
30	124	103	80	105	91	77	97	85	75	--	--	--
BLACK OAK												
12	--	--	59	--	--	55	--	--	54	--	--	--
14	83	66	61	73	60	57	66	57	55	--	--	--
16	87	70	63	76	63	58	69	60	57	--	--	--
18	91	74	64	79	66	60	72	63	59	--	--	--
20	95	77	66	83	69	62	75	65	60	--	--	--
22	99	81	68	86	72	64	78	68	62	--	--	--
24	103	85	70	90	75	66	81	71	64	--	--	--
26	107	89	71	93	78	67	84	73	65	--	--	--
28	111	93	73	96	81	69	87	76	67	--	--	--
30	115	97	75	100	84	71	90	78	69	--	--	--
NORTHERN RED OAK												
12	--	--	55	--	--	54	--	--	53	--	--	--
14	95	78	58	87	67	56	79	64	55	--	--	--
16	97	80	60	89	69	59	81	66	58	--	--	--
18	99	82	63	91	71	62	83	68	61	--	--	--
20	101	84	65	93	74	64	85	70	63	--	--	--
22	103	86	68	96	76	67	87	72	66	--	--	--
24	106	89	71	98	78	69	89	74	68	--	--	--
26	108	91	73	100	80	72	92	77	70	--	--	--
28	110	93	76	102	82	74	94	79	72	--	--	--
30	113	95	79	104	84	77	96	81	75	--	--	--
CHESTNUT OAK												
12	--	--	51	--	--	51	--	--	51	--	--	--
14	91	67	51	75	60	51	69	57	51	--	--	--
16	92	68	52	76	61	52	70	58	52	--	--	--
18	93	69	52	77	62	52	71	59	52	--	--	--
20	94	70	53	78	63	53	72	60	53	--	--	--
22	95	71	53	80	63	53	73	60	53	--	--	--
24	97	72	54	81	64	54	74	61	54	--	--	--
26	98	73	54	83	65	54	75	62	54	--	--	--
28	99	75	55	84	66	55	76	63	55	--	--	--
30	100	76	55	85	67	55	77	64	55	--	--	--
WHITE OAK												
12	--	--	59	--	--	54	--	--	52	--	--	--
14	84	71	61	71	61	56	66	58	53	--	--	--
16	87	74	63	74	64	58	68	60	55	--	--	--
18	90	77	65	76	67	59	70	62	57	--	--	--
20	92	80	67	79	69	61	72	64	59	--	--	--
22	95	83	69	82	71	63	75	66	61	--	--	--
24	98	86	71	84	74	65	77	68	62	--	--	--
26	100	89	73	87	76	66	80	71	64	--	--	--
28	102	92	75	89	79	68	82	73	66	--	--	--
30	105	95	77	92	81	70	84	75	67	--	--	--

Table 7.--Logging and milling costs per M b.f.

Item	Source of data	Tree d.b.h. (Inches)				
		12	16	20	24	30
		- - - - - - - - Dollars - - - - - - - -				
Fell and buck						
Soft hardwood, sound	(1/)	3.80	2.50	2.00	1.60	1.40
Including 15% cull		4.40	2.90	2.30	1.85	1.60
Hard hardwood, sound		6.00	4.40	3.50	2.90	2.40
Including 15% cull		6.90	5.10	4.00	3.30	2.75
Skidding 16 chains						
All species, sound	(2/)	5.40	3.50	2.80	2.60	1.80
Including 10% cull		5.90	3.85	3.10	2.90	2.00
Loading						
All species, sound	(3/)	3.00	2.00	1.60	1.40	1.20
Including 10% cull		3.30	2.20	1.80	1.50	1.30
Hauling 1 mi. woods and 15 mi. highway						
All species, sound	(4/)	7.10	7.10	7.10	7.10	7.10
Including 10% cull		7.80	7.80	7.80	7.80	7.80
Total logging						
Soft hardwoods		23.40	18.75	17.00	16.00	14.70
Hard hardwoods		25.90	21.00	18.70	17.50	15.80
Milling 5/		48.00	38.00	33.00	27.50	31.50
Total						
Soft hardwoods		71.40	56.75	50.00	43.50	46.25
Hard hardwoods		73.90	59.00	51.75	45.00	47.25

1/ From table 1, Southeastern Forest Expt. Sta. Paper 30, October 1953.
2/ From table 2, " " " " " " " "
3/ From table 3, " " " " " " " "
4/ From table 4, " " " " " " " "
5/ Milling costs shown are based on Region 8 appraisal instructions for band mills. The spread in costs both ways from the $33.00 average is based on Tennessee Valley Authority circle mill studies and may not be accurate for band mills but has little effect on maturity sizes.

Table 8.--Stumpage values [1] of trees by size and grade
(In dollars)

D.b.h. (Inches)	1-log trees A	1-log trees B	1-log trees C	2-log trees A	2-log trees B	2-log trees C	3-log trees A	3-log trees B	3-log trees C
				WHITE ASH					
12	--	--	.30	--	--	.70	--	--	1.10
14	--	--	.90	--	--	1.50	--	--	2.30
16	5.20	4.20	2.00	7.20	4.90	3.10	8.40	6.00	4.40
18	7.80	6.40	4.00	11.00	8.10	5.80	13.50	10.00	8.00
20	11.00	9.40	6.30	17.00	13.00	9.80	20.50	16.00	12.00
22	15.50	13.00	9.50	23.50	19.00	14.80	29.00	23.50	19.50
24	20.50	17.00	13.00	32.00	26.00	20.50	39.00	32.50	27.50
26	26.00	22.00	16.50	41.00	33.50	27.00	51.00	42.00	36.00
28	31.50	26.50	20.00	50.00	41.00	33.50	62.00	52.00	45.00
30	36.50	30.50	22.50	58.00	49.00	40.00	72.00	62.00	54.00
				BASSWOOD					
12	--	--	1.00	--	--	1.70	--	--	1.70
14	--	--	1.90	--	--	3.00	--	--	3.20
16	7.50	4.80	3.20	10.50	7.00	4.90	12.00	8.00	5.70
18	11.00	7.50	5.20	15.00	10.50	7.70	18.00	12.50	9.40
20	15.00	11.00	7.70	21.50	15.00	11.50	25.00	18.00	14.50
22	20.50	15.00	11.00	29.50	21.00	16.50	34.50	25.50	21.00
24	26.50	19.50	14.50	38.00	27.50	22.00	45.00	34.00	29.00
26	32.50	24.00	18.50	47.00	35.00	28.50	57.00	43.00	37.50
28	38.50	29.00	22.00	56.00	42.00	35.00	69.00	53.00	46.00
30	44.00	33.00	25.50	65.00	49.00	41.00	79.00	61.00	54.00
				BEECH					
12	--	--	.15	--	--	.15	--	--	.20
14	--	--	.30	--	--	.40	--	--	.50
16	3.20	1.70	.70	4.00	2.00	.90	4.20	2.50	1.30
18	5.00	2.90	1.40	6.80	3.70	2.00	7.00	4.40	2.70
20	7.30	4.60	2.40	10.40	6.20	3.70	11.00	7.20	5.00
22	10.20	7.00	4.00	15.00	9.70	6.20	16.50	11.00	8.00
24	13.50	10.00	6.00	20.00	14.00	9.50	23.00	16.50	12.50
26	17.00	13.00	8.00	26.00	18.50	13.00	30.00	22.00	17.00
28	20.50	16.00	10.00	31.50	23.50	17.00	37.50	28.50	22.00
30	23.50	19.00	12.50	37.00	28.50	21.50	45.00	34.50	27.00
				YELLOW BIRCH					
12	--	--	.10	--	--	.15	--	--	.20
14	--	--	.30	--	--	.40	--	--	.50
16	5.60	2.90	.60	7.20	3.30	1.00	7.60	3.90	1.20
18	8.60	5.00	1.40	11.50	6.00	2.20	12.50	6.70	2.70
20	13.00	8.00	2.60	18.00	10.00	4.30	20.00	11.00	5.30
22	18.50	12.00	4.40	27.00	15.50	7.50	30.00	17.00	9.30
24	26.00	17.00	7.00	38.00	22.00	11.50	42.00	25.00	14.50
26	34.00	22.50	10.00	50.00	30.00	16.00	55.00	34.00	21.00
28	42.00	28.00	13.00	64.00	38.00	21.00	70.00	45.00	28.00
30	51.00	33.50	16.00	77.00	45.00	26.00	85.00	55.00	35.00
				HARD MAPLE					
12	--	--	.60	--	--	1.40	--	--	1.70
14	--	--	1.30	--	--	2.40	--	--	3.00
16	5.90	4.00	2.30	8.50	5.60	4.20	9.50	7.20	5.30
18	8.40	5.90	4.00	12.50	8.60	6.80	14.50	11.20	8.80
20	11.50	8.30	6.20	17.50	12.60	10.50	21.00	16.50	13.50
22	15.50	11.50	9.00	23.50	17.50	15.00	29.50	23.50	20.00
24	20.50	15.00	12.00	30.50	23.50	20.50	39.00	31.50	27.00
26	25.50	18.50	15.00	38.00	29.50	26.50	50.00	40.00	35.00
28	30.50	22.50	18.00	46.00	36.00	32.50	60.00	49.00	43.00
30	35.00	26.00	21.00	53.00	45.00	38.00	70.00	57.00	51.00
				SOFT MAPLE					
12	--	--	.20	--	--	.35	--	--	.35
14	--	--	.50	--	--	.80	--	--	.95
16	3.80	2.50	1.20	3.80	2.50	1.80	4.30	2.90	2.20
18	5.80	4.20	2.30	6.60	4.80	3.60	7.60	5.40	4.30
20	8.80	6.70	4.00	10.50	8.00	6.20	12.50	9.20	7.50
22	12.00	9.80	6.20	16.00	12.50	9.60	19.00	14.50	12.00
24	16.00	13.50	9.00	22.50	17.50	14.00	27.00	20.50	17.00
26	20.00	17.50	12.00	29.50	23.50	18.50	35.50	27.50	22.50
28	24.50	21.50	15.00	36.50	30.00	23.50	45.00	35.00	28.50
30	28.50	25.50	17.50	43.00	36.00	28.00	54.00	42.00	34.00

D.b.h. (Inches)	1-log trees A	1-log trees B	1-log trees C	2-log trees A	2-log trees B	2-log trees C	3-log trees A	3-log trees B	3-log trees C	4-log trees A	4-log trees B	4-log trees C
						YELLOW - POPLAR						
12	--	--	1.30	--	--	1.90	--	--	2.30	--	--	2.50
14	--	--	2.20	--	--	3.40	--	--	4.30	--	--	4.50
16	5.60	5.00	3.60	8.40	6.50	5.50	10.00	8.00	7.00	10.00	8.50	7.50
18	8.20	7.20	5.80	12.50	10.00	8.50	15.00	12.50	11.50	15.50	13.50	12.50
20	12.00	10.00	8.40	18.00	14.50	13.00	22.00	18.50	17.00	23.50	20.00	19.00
22	16.00	13.50	11.50	25.00	20.50	18.00	30.00	26.00	24.00	33.00	29.00	27.00
24	21.00	17.50	15.00	33.00	26.50	23.50	40.00	34.00	31.50	44.00	38.00	36.00
26	26.50	22.00	19.00	41.00	33.00	29.50	50.00	42.00	39.00	55.00	48.00	45.00
28	32.00	26.00	23.00	49.00	39.00	35.50	60.00	51.00	47.00	67.00	58.00	55.00
30	37.00	30.00	26.00	56.00	45.00	41.00	68.00	58.00	53.00	78.00	66.00	64.00
						HICKORY						
12	--	--	(2/)	--	--	(2/)	--	--	(2/)	--	--	--
14	--	--	(2/)	--	--	(2/)	--	--	(2/)	--	--	--
16	1.00	.40	.10	.90	.40	.05	.70	(2/)	(2/)	--	--	--
18	2.00	.90	.20	1.90	.90	.20	1.60	.20	(2/)	--	--	--
20	3.60	1.70	.40	3.60	1.70	.50	3.20	1.00	.30	--	--	--
22	5.80	2.90	.70	6.00	3.00	.90	5.80	2.50	.60	--	--	--
24	8.50	4.50	1.20	9.00	4.80	1.50	9.00	5.00	1.00	--	--	--
26	11.50	6.50	1.90	12.50	7.00	2.30	13.00	8.00	1.90	--	--	--
28	14.50	8.50	2.50	16.50	9.40	3.20	18.00	11.00	2.60	--	--	--
30	--	--	--	--	--	--	--	--	--	--	--	--
						BLACK OAK						
12	--	--	.20	--	--	.20	--	--	.20	--	--	--
14	--	--	.50	--	--	.50	--	--	.50	--	--	--
16	3.80	1.80	1.00	4.00	1.80	1.20	3.80	1.80	1.20	--	--	--
18	5.80	3.40	1.90	6.80	3.70	2.50	6.80	4.00	2.80	--	--	--
20	8.50	5.50	3.20	10.80	6.40	4.20	11.00	7.30	5.20	--	--	--
22	12.00	8.00	4.80	15.50	10.00	7.00	17.00	12.00	8.50	--	--	--
24	16.00	11.00	6.70	21.00	14.00	10.00	23.50	17.00	12.50	--	--	--
26	20.00	14.00	8.70	27.00	19.00	13.00	31.50	22.50	17.00	--	--	--
28	24.00	17.50	11.00	33.50	24.00	16.50	39.50	28.50	21.50	--	--	--
30	28.00	21.00	12.50	39.00	28.00	19.50	47.00	34.50	26.00	--	--	--
						NORTHERN RED OAK						
12	--	--	.15	--	--	.30	--	--	.35	--	--	--
14	--	--	.40	--	--	.70	--	--	.80	--	--	--
16	4.40	2.60	.90	6.40	2.80	1.40	6.60	3.00	1.70	--	--	--
18	6.60	4.10	1.80	9.50	4.60	2.80	10.00	5.30	3.50	--	--	--
20	9.50	6.20	3.10	13.50	7.20	4.80	15.00	8.80	6.00	--	--	--
22	12.50	9.00	4.90	19.00	11.00	7.80	21.50	13.00	9.60	--	--	--
24	16.00	12.00	7.00	25.00	15.00	11.50	29.00	19.00	14.00	--	--	--
26	20.00	15.00	9.30	31.50	20.00	15.50	37.00	25.00	19.00	--	--	--
28	24.00	18.00	11.80	38.00	25.00	19.50	45.00	31.50	24.00	--	--	--
30	27.00	21.00	14.00	44.00	30.00	24.00	53.00	38.00	29.00	--	--	--
						CHESTNUT OAK						
12	--	--	(2/)	--	--	(2/)	--	--	(2/)	--	--	--
14	--	--	(2/)	--	--	(2/)	--	--	(2/)	--	--	--
16	4.20	1.30	.15	4.20	1.70	.30	4.30	1.60	.30	--	--	--
18	6.10	2.60	.50	7.00	3.50	.90	7.00	3.50	1.20	--	--	--
20	8.70	4.40	1.10	10.00	5.80	2.10	11.00	6.00	2.90	--	--	--
22	11.70	6.20	2.10	14.00	8.80	3.80	16.00	9.50	5.30	--	--	--
24	15.00	8.50	3.30	19.00	12.00	6.00	21.00	13.50	8.20	--	--	--
26	19.00	11.00	4.70	23.50	16.00	8.50	27.00	18.00	11.80	--	--	--
28	22.50	13.00	6.20	28.50	19.50	11.00	32.50	23.00	15.00	--	--	--
30	25.00	14.50	7.50	33.00	22.50	13.50	38.00	27.00	18.00	--	--	--
						WHITE OAK						
12	--	--	.20	--	--	.20	--	--	.20	--	--	--
14	--	--	.50	--	--	.60	--	--	.70	--	--	--
16	4.00	2.50	1.20	4.40	2.70	1.30	4.60	2.70	1.60	--	--	--
18	6.00	4.20	2.20	6.80	4.60	2.70	7.60	4.80	3.30	--	--	--
20	8.80	6.40	3.80	10.00	7.40	4.60	11.80	8.00	6.00	--	--	--
22	12.00	9.00	5.80	14.50	11.00	7.50	17.00	12.50	9.50	--	--	--
24	15.50	12.00	8.00	19.50	15.00	10.50	23.50	17.50	13.50	--	--	--
26	19.50	15.50	10.50	25.50	20.00	14.50	30.50	23.00	18.00	--	--	--
28	23.00	18.50	12.50	31.50	25.00	18.00	38.00	29.00	23.00	--	--	--
30	26.00	21.50	14.50	37.50	30.00	21.00	45.00	35.00	27.00	--	--	--

1/ Data are from tree-value curves on semi-log paper.
2/ Negative stumpage values. Grade A data for hickory are of uncertain value for the Appalachians, since they were collected in Ohio, Indiana, and Illinois.

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Table 9.--Economic maturity; maximum d.b.h. of trees by grade, size, and vigor class, permitting 3 percent or higher compound earnings 1/

Species	Log length	Vigor class 2/	10-yr. d.b.h. growth 3/	Tree grade A	B	C	Average
			Inches	D.b.h. inches 4/			
White ash	1, 2, 3	I	3.20	28	28	30	28
	1, 2, 3	II	2.00	24	24	25	24
	1	III	1.20	--	--	19	19
	2, 3	III	1.20	--	18	20	19
Basswood	1, 2, 3	I	2.30	24	24	24	24
	1, 2, 3	II	1.60	20	20	22	22
	1, 2, 3	III	1.20	--	--	17	17
Beech	1, 2, 3	I	1.60	22	24	25	24
	1, 2, 3	II	1.10	--	19	21	20
	1, 2, 3	III	.80	--	--	18	18
Yellow birch	1, 2, 3	I	2.00	25	26	27	26
	1	II	1.30	--	20	24	22
	2, 3	II	1.30	19	21	23	21
	1, 2, 3	III	.80	--	--	19	19
Hickory	1	I	1.85	25	26	27	26
	2	I	1.85	26	27	28	27
	3	I	1.85	28	28	28	28
	1, 2, 3	II	1.30	23	24	26	24
	1, 2, 3	III	1.00	21	22	23	23
Hard maple	1, 2, 3	I	2.30	24	24	25	24
	1	II	1.50	--	--	21	21
	2	II	1.50	--	19	21	20
	3	II	1.50	19	20	22	20
	1, 2, 3	III	1.00	--	--	15	15
Red maple	1	I	2.30	25	26	27	26
	2, 3	I	2.30	26	27	27	27
	1, 2, 3	II	1.30	20	21	21	20
	1, 2, 3	III	1.10	19	19	20	19
Yellow-poplar	1, 2, 3, 4	I	2.80	26	26	26	26
	1, 2, 3, 4	II	1.85	21	23	23	23
	1, 2, 3, 4	III	1.40	18	19	19	18
Black oak	1, 2, 3,	I	2.30	25	26	26	26
	1	II	1.70	20	22	24	22
	3	II	1.70	23	24	25	23
	1	III	1.30	--	20	21	20
	2, 3	III	1.30	20	22	22	21
N. R. oak	1	I	3.60	28	29	30	29
	2	I	3.60	28	30	31	30
	3	I	3.60	30	31	32	31
	1	II	2.30	24	25	26	25
	2	II	2.30	24	26	27	26
	3	II	2.30	25	26	27	26
	1, 2	III	1.90	20	22	24	22
	3	III	1.90	22	24	24	23
Chestnut oak	1, 2	I	2.10	23	23	27	25
	3	I	2.10	23	25	27	25
	1	II	1.65	20	22	26	23
	2	II	1.65	20	23	26	23
	3	II	1.65	22	24	26	24
	1, 2, 3	III	1.00	--	19	22	21
White oak	1	I	2.10	22	24	26	24
	2, 3	I	2.10	24	25	26	25
	1	II	1.65	21	22	24	22
	2	II	1.65	22	23	24	23
	3	II	1.65	22	24	24	23
	1, 2, 3	III	1.00	--	--	19	19
Scarlet oak	1, 2, 3	I	2.80	16	21	25	21
	1, 2, 3	II	1.85	--	--	21	21
	1, 2, 3	III	1.40	--	--	20	20

1/ Assuming equal growing time between each 2-inch d.b.h. class.
2/ Vigor classes as described by Holcomb and Bickford, Northeastern Forest Expt. Sta. Paper 52.
3/ Growth rates based on smooth curve data from above report, TVA, and local data.
4/ Sizes are usually within 1 inch of the values listed.

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